

1   **WHAT IS CLAIMED IS:**

2           1. An apparatus for precise distance measurement, comprising:  
3           a multiple frequency generator that generates a base signal, an interim  
4   signal and a transmission signal;  
5           a laser transmitter connected to the multiple frequency generator to  
6   output a light signal with the transmission signal to a target;  
7           an optical receiver that receives the light signal from the laser  
8   transmitter reflected by a target and outputs a measurement signal; wherein the  
9   optical receiver is connected to the multiple frequency generator and mixes the  
10   base signal and the reflected light signal to output a measurement signal;  
11          a first measuring unit connected to the multiple frequency generator  
12   and the optical receiver obtains a time difference by calculating a time  
13   difference between the measurement signal and the transmission signal;  
14          a second measuring unit connected between the multiple frequency  
15   generator and the optical receiver to calculate a phase difference by comparing  
16   the measurement signal and the interim signal; and  
17          a central processing unit connected to the first and second measuring  
18   units to calculate a distance between the laser transmitter and a target by the  
19   time difference and the phase difference.

20          2. The apparatus as claimed in claim 1, wherein the multiple frequency  
21   generator comprises:  
22          an oscillator that generates the base signal;  
23          a frequency divider connected to the oscillator, wherein the frequency  
24   divider divides the base signal to the interim signal; and

1           a frequency synthesizer connected to the frequency divider to generate  
2   the transmission signal.

3           3. The apparatus as claimed in claim 1, wherein the first measuring unit  
4   comprises:

5           a square wave generator connected to the optical receiver and the  
6   multiple frequency generator to generate a square wave signal; and

7           a wave width measuring unit connected to the square wave generator  
8   and the multiple frequency generator to calculate a wave width of the square  
9   wave signal.

10          4. The apparatus as claimed in claim 1, wherein the second measuring  
11   unit comprises:

12          a signal corrector connected to the optical receiver to modify the  
13   measurement signal's wave form and generate a modified measurement signal;  
14   and

15          a phase comparator connected to the signal corrector and the multiple  
16   frequency generator to calculate the phase difference between the interim signal  
17   and the modified measurement signal.

18          5. The apparatus as claimed in claim 1, wherein the second measuring  
19   unit comprises:

20          a signal corrector connected to the optical receiver to modify the  
21   measurement signal;

22          a mixer connected to the multiple frequency generator to mix the  
23   transmission signals to generate a reference signal; and

24          a phase comparator connected to the signal corrector and the mixer to

1 calculate the phase difference between the reference signal and the  
2 measurement signal.

3 6. The apparatus as claimed in claim 4, wherein the phase comparator  
4 comprises:

5 a first mixer connected to the optical receiver and the multiple

6 frequency generator mixed the measurement signal and the interim signal;

7 a first low pass filter connected to the first mixer to output a first DC  
8 value;

9 a phase locked loop (PLL) connected to multiple frequency generator  
10 to generate a delay interim signal with a  $\frac{\pi}{2}$  phase delay;

11 a second mixer connected between the PLL and the optical receiver to  
12 mix the delay interim signal and the measurement signal;

13 a second low pass filter connected to the second mixer to output a  
14 second DC value; and

15 a logic element connected to the first and second low pass filters to  
16 calculate the phase difference by dividing the first and second DC values.

17 7. The apparatus as claimed in claim 5, wherein the phase comparator  
18 comprises:

19 a first mixer connected to the optical receiver and the multiple

20 frequency generator mixed the measurement signal and the interim signal;

21 a first low pass filter connected to the first mixer to output a first DC  
22 value;

23 a phase locked loop (PLL) connected to multiple frequency generator

1 to generate a delay interim signal with a  $\frac{\pi}{2}$  phase delay;  
2 a second mixer connected between the PLL and the optical receiver to  
3 mix the delay interim signal and the measurement signal;  
4 a second low pass filter connected to the second mixer to output a  
5 second DC value; and  
6 a logic element connected to the first and second low pass filters to  
7 calculate the phase difference by dividing the first and second DC values.  
8 8. The apparatus as claimed in claim 4, wherein the signal corrector is  
9 composed of a band-pass filter connected to the optical receiver and a wave  
10 form shaper connected to the band-pass filter and the phase comparator.  
11 9. The apparatus as claimed in claim 5, wherein the signal corrector is  
12 composed of a band-pass filter connected to the optical receiver and a wave  
13 form shaper connected to the band-pass filter and the phase comparator.  
14 10. The apparatus as claimed in claim 6, wherein the signal corrector is  
15 composed of a band-pass filter connected to the optical receiver and a wave  
16 form shaper connected to the band-pass filter and the phase comparator.  
17 11. The apparatus as claimed in claim 7, wherein the signal corrector is  
18 composed of a band-pass filter connected to the optical receiver and a wave  
19 form shaper connected to the band-pass filter and the phase comparator.